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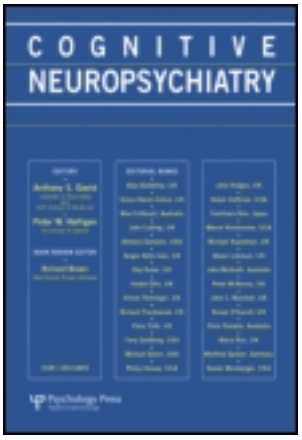

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The tell-tale brain: Unlocking the mystery of human nature

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Book Review
Tabula Rama

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> The table of the self can continue to stand without one of the legs, but if too many are lost its stability becomes severely compromised. (Ramachandran, 2011, p. 253)

What a fabulous book! Ironically, it is "fabulous" to a degree that will unsettle many scientists, as Ramachandran's ratio of fables-to-facts may exceed what they can tolerate. As Ramachandran notes: "In doing science one is often forced to choose between providing precise answers to boring (or trivial) questions such as, How many cones are there in the human eye? or vague answers to big questions such as, What is consciousness?" (p. 311). Ramachandran is no cone counter, and one's opinion of his book may depend on just how vague one considers his answers to be to the big questions he raises.

These big questions are treated in nine chapters, which partially fuse to form seven "legs" supporting Ramachandran's table—his thesis of the uniqueness of human nature. Chapters 1 and 2 address phantom limbs, and visual perception and cognition, respectively. These chapters recycle material from two of Ramachandran's former books and are based on his most influential experimental contributions to the scientific literature. The relevant arguments in favour of human uniqueness here are plasticity and (visual) awareness. Although Ramachandran appreciates that animals do have phantom limbs and do show cortical remapping after the loss of a limb, he notes that the plasticity seen in the human brain ("*Homo plasticus*") dwarfs that of nonhuman primates. In Chapter 2, he presents a useful and entertaining introduction to the different visual pathways and their functional dissociability, which may produce apparently paradoxical behaviours such as those observed in blindsight or Capgras delusion. I have the impression that "A Neuroscientist's Quest for What Makes Us Human" (the subtitle of the US edition) was not the primary motivation for including

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these chapters. Rather, I suspect it was the appeal of intriguing somatosensory and visual phenomena, the vivid description of which Ramachandran is justly renowned for. The argument of human hyperneuroplasticity seems to be quantitative rather than qualitative, and his discussion of the emergence of visual awareness via phylogenetically new visual pathways does not add a particularly novel twist to the ongoing debate about human versus animal consciousness.

Let us then proceed to three more legs of Ramachandran's table. The synaesthesia/creativity connection is one (Chapter 3); it is closely attached to the leg of mirror neurons (Chapters 4 and 5), which itself can barely be separated from that of language (Chapter 6). "Loud Colors and Hot Babes: Synesthesia" revisits the descriptions familiar from "Purple Numbers and Sharp Cheese" (Chapter 4 in Ramachandran, 2004). At some length—but every single line pays dividends—we are persuaded that synaesthetic pairings of digit and colour are not just learned associations. Consider, for example, "Susan", who experiences a 7 in black print as red, does not have any colour impression for the Roman numeral VII, needs some time to build up a colour percept when a 7 is drawn on her skin, experiences a whole rainbow of colours when listening to someone speaking aloud "seven, five, three, two, eight ...", and finds a 7 printed in green hideous. It is difficult to determine whether an animal can experience synaesthesia or how far its faculty for cross-modal associations might be developed; hence, what Ramachandran proposes as uniquely human is synaesthesia as a principle that goes beyond the merging of the senses on a phenomenal level. In a sense, he writes, we are all synaesthetes when automatically (and universally) matching the name "*bouba*" with an undulating amoeba-contoured line drawing, but "*kiki*" with a jagged form resembling a piece of shattered glass (see later).

In Chapter 4, Ramachandran introduces "the neurons that shaped civilization", i.e., mirror neurons, the type of brain cells whose purported functional range embraces just about everything, from low-level visuomotor matching to the most abstract forms of mind reading. That, at any rate, is how mirror neurons are described in the popular press, and Ramachandran's description is almost as effusive. He first delineates how mirror neurons were discovered in the monkey ventral premotor cortex and subsequently also in inferior parietal areas. He then describes a class of "sensory mirror neurons" that fire not only when touch or painful stimuli are directed to one's own body, but also when tactile stimulation of another person is visually observed. It is not just frontal inhibitory circuits that are involved in preventing a person from literally feeling another person's touch and pain, but also active "null signals" from one's corresponding tactile receptors, which remain unstimulated. Accordingly, Ramachandran describes an amputee whose "null signals" could no longer reach the brain and who felt observed touch on his phantom limb. As exceptional as such a case

might seem, empathy for pain that reaches the quality of sensation is now recognised as relatively common in amputees (Fitzgibbon et al., 2010).

In a lengthy footnote, Ramachandran convincingly rebuts a number of common doubts about the general importance of the human mirror neuron system. He notes that several properties of mirror neurons are crucial in an evolutionary sense. First, they allow us not only to see the world from our conspecifics' vantage point, but also to take the other's *conceptual* stance ("I see your point"), and to imitate abstract thought in addition to motor action. In the most general sense, mirror neurons thus enabled the transition from slow-motion genetic evolution to the sudden leaps possible in cultural evolution. Without a sophisticated mirror system, incidental innovations, such as fire making, could never have spread across early hominid societies with the rapidity they did. For a discussion of the controversy about the role of mirror neurons in the theory-of-mind deficits that characterise the autistic spectrum disorders (Chapter 5), I refer the interested reader to the discussion in Gallese, Gernsbacher, Heyes, Hickok, and Iacoboni (2011). Suffice it to say that, for Ramachandran, the evidence clearly speaks in favour of "broken mirrors" or at least a dormant mirror system at the heart of autism.

Who would want to miss a discussion of language in the list of uniquely human faculties? This is presented in Ramachandran's next chapter, "The Power of Babble: The Evolution of Language". Why were the genes involved in shaping a purported *language acquisition device* selected in the first place? Ramachandran's answer might surprise every linguist. The sound of object nouns shows a nonarbitrary correspondence to the object's visual features: proof is the *bouba–kiki* experiment referred to earlier. Mediation of the cross-modal abstraction involved in bringing together vision and sound are mirror neurons in Broca's area. Ramachandran speculates that these might also mediate the relationship between mouth (tongue, lip, etc.), posture, and the produced sound: in "*fudge*", "*trudge*", "*sludge*", and "*smudge*" the prolonged tongue pressure to the palate is suddenly released, and the sound produced is reminiscent of that of a foot suddenly released from the mud. A similar cross-activation process between mouth and hand motor maps is to be assumed. Analogous to synaesthesia, this coactivation of two distinct motor maps, "synkinesia", may have played a pivotal role in transforming gestural language into spoken language. This leads us on to syntax. Ramachandran suggests that tool manufacture, and especially the more sophisticated subassembly techniques needed for constructing multipart tools, became coopted for constructing multipart sentences—manual-constructional syntax was mirrored into linguistic syntax. Ultimately then, the "language acquisition device" was formed by a process of exaptation, building upon tool manufacturing, cross-modal association, and semantics. Anatomically, this required an integrative interplay between the inferior parietal lobe, ventral premotor cortex, and superior temporal convolution, all

in the left hemisphere, "not coincidentally, perhaps, . . . the very areas in which mirror neurons abound" (p. 182). Whether or not mirror neurons are actually involved here, the connections that Ramachandran establishes between sound–shape associations, correspondences between the meaning of a word and the morphological configuration of the speech apparatus, while pronouncing that word, and, finally, the resonance between speech and hand motor maps, seem logically sound.

The aesthetic sense (Chapters 7 and 8) forms the next leg supporting *tabula Rama*. Starting out from "universal principals of esthetics" common to humans, bowerbirds, and bees, Ramachandran quickly proceeds to what he labels his "nine laws of aesthetics" (p. 200; listed already in Ramachandran, 2004), which are supposed to be universally human. Some of these laws are admittedly well-established principles of Gestalt perception, and Ramachandran discusses each of them, always keeping an evolutionary perspective and trying to relate present-day aesthetic preferences to certain survival-relevant perceptual processing characteristics of our ancestors. Although I agree that the enjoyment (and production) of visual and sculptural art is probably a uniquely human luxury, I am not convinced that Ramachandran's nine artistic universals capture what is unique about this capacity. However, rather than defend my scepticism, I would like to comment on one of these universals in particular, dubbed "The abhorrence of coincidence". Here I accuse Ramachandran of something I bet he has never been accused of before—I accuse him of being *under*inclusive in this brief section. A bare 38 lines are devoted to this enormously central law—central not only for aesthetics, but also for cognition, scientific reasoning, and the formation of religious belief. Not only do we "abhor" coincidences in pictures, we also abhor them in attempts to "behave randomly" (Brugger, 1997). By "we", I refer not only to human beings but to living creatures down to unicellular organisms and even haploid flagellates (Brugger, Macas, & Ihlemann, 2002).

We are inclined to overinterpret coincidences in everyday life ("What a coincidence!"). In fact, the abhorrence of coincidence comes in degrees, and as a personality variable it predicts both a scientist's inclination towards Type I or Type II errors and a laypersons' belief in some hidden forms of causation (Brugger, Regard, Landis, & Graves, 1995). Ramachandran himself uses the term "coincidence" several times throughout his book. He appreciates that it is almost certainly a coincidence that Nabokov saw the letter K as orange in colour (orange being a perfect blend of his parents' synaesthetic percepts for K: father yellow, mother red). Hence, no further theoretical elaborations follow (p. 103). On the other hand, he considers the observation that both synaesthesia and metaphor make nonarbitrary links between seemingly unrelated percepts or thoughts to be *more than* "just a coincidence" (p. 104). Consequently, we are presented with an evolutionary

account of a common development and shared neural circuits of synaesthetic and metaphor processing. On the basis of his low threshold for coincidence rejection, Ramachandran (deliberately) risks a Type I error, whereas a scientist preoccupied with counting cones in the eye would almost certainly see nothing but a coincidental relation between synaesthesia and metaphor. Ironically, Ramachandran fails to recognise the abhorrence of coincidences as causally involved in the rubber hand illusion and the illusion of a phantom head (p. 325, footnote 18). In a nutshell, the law of the "abhorrence of coincidences" may apply to human beings' aesthetic sense, but it applies in a much more fundamental sense to life quite generally.

Finally, there is "leg" number seven, the nature of self-awareness. What made us "An Ape with a Soul" (the title of Chapter 9); how did introspection evolve? The chapter opens with a case history used to illustrate that "the self is not the monolithic entity it [who exactly?] believes itself [who exactly?] to be" (p. 247). Ramachandran then proceeds to define different aspects of the self: embodiment; privacy, unity, and continuity; social embedding; self-awareness and free will. Thus, although self-awareness is identified as just one of aspect of the self (which makes sense), Chapter 9, which Ramachandran declares will "take a stab at the most challenging problem of all, the nature of self-awareness" (p. xiv), is in fact a chapter on the nature of the self more generally. It presents an entertaining list of abnormalities in each of the previously mentioned aspects. Ever more cases are introduced of patients, whose clinical semiology just *has to* appear bizarre to nonclinicians. Accordingly, many popular reviews of Ramachandran's book (and of some of his earlier writings) jump on these spectacular cases, superficially focusing on the names of the respective behavioural abnormalities ("telephone syndrome", "walking corpse syndrome"), but missing the lesson they teach us about corporeal awareness and the experience of the self. I am afraid that many readers will approach this book much like nineteenth-century people approached the medical curiosities exposed in Barnum's circus. Perhaps all this is an unavoidable drawback of an author's ability to write in a sexy Sacksian style.

"Embodiment", the fact that we tend to identify our self with our body, is illustrated by the disturbances of, among others, apotemnophilia and transsexuality. The first disorder, apotemnophilia, refers to the desire of amputation of a completely normal limb, "normal" with respect to the "flesh and bone" aspects of the body part and its functionality. However, people with apotemnophilia lack the animation ("*Beseelung*") that usually makes one identify a limb as one's own—they lack the "phantom within". This limb-specific identity disorder is arguably spread over the whole body in transsexual people; at least with respect to the aspects of gender and sex, these people feel trapped in the wrong body. Out-of-body experiences are discussed under the heading "Unity of the Self", although they could have

exemplified the aspect of embodiment at least as well (conversely, apotemnophilia presents a challenge also to the unity aspect). The aspect of self-awareness is addressed in the frame of three rather disparate clinical pictures: Cotard syndrome (the nihilistic delusion of being dead), the identification with god, and panic attacks. Considering that Ramachandran had earlier declared this aspect of the self the most uniquely human, this is the least satisfying section of the chapter. And indeed, this chapter appears to me the least logically structured of the entire book. Too many symptoms and syndromes are addressed, the individual sections seem hastily written, and we lack both an integrative summary and a clearer focus on the ability of the self to contemplate itself. Perhaps the difficulty here (more than in any other chapter) is the precise meaning of the key terms. On page 248 philosophy is mentioned, for once admiringly: "... philosophy has been extremely useful in maintaining semantic hygiene and emphasizing the need for clarity in terminology". Yet, just one page later, Ramachandran uses the term "conscious" in a rather sloppy way, and it's not just philosophers who have cause to complain about a relatively unhygienic mixing of conceptual levels. He writes: "We know, after all, that the liver and the spleen are not conscious; only the brain is" and a bit further on: "... only some parts of the brain are conscious" (p. 249). The fact is that neither the brain nor parts of the brain are any more conscious than liver or spleen are. It is the brain (or parts of it) that *enables a person to be conscious*, and it is different parts of the brain that mediate consciousness as opposed to unconsciousness and that enable a person to become conscious of herself. More clarity here may have helped Ramachandran to reach a broader audience.

Before summing up, I would like to comment on the cornucopia of concrete suggestions that Ramachandran provides regarding experimental tests of specific hypotheses. This is what I most admire in his writing: The associations may be remote, the conclusions sometimes bold and sweeping, but there is never a speculation that is not accompanied by some concrete suggestion as to how to put it to the test. Some of these suggestions are tongue-in-cheek, but others could potentially lead to revolutionary insights. Sometimes a reference would have helped the nonspecialist reader to recognise that a procedure was simply *applied* by Ramachandran's group in a particular context, and was already known from other contexts (e.g., minifying lenses may be used to alleviate phantom limb pain [p. 36] or to reduce the desire for amputation [p. 257], but the use of size-changing lenses to influence tactile-somesthetic perception goes back to work by Kennet, Taylor-Clarke, & Haggard, 2001). Likewise, biting on pencils to force the facial muscles into forming a smile that is not accompanied by the corresponding affect may confuse the mirror neuron system (p. 143), but the procedure was famously introduced back in the 1980s by Strack, Martin, and Stepper (1988). Also, larger experiments, like the neuroimaging study

with grapheme-colour synaesthetes that started in 2003 and lasted four full years (p. 100) could have been discussed against the background of similar work, executed more swiftly and published more than a decade earlier (Paulesu et al., 1995). In a similar vein, when it comes to questions of scientific or conceptual priority, a more modest use of the words "I" and "we" would seem desirable: "Astonishingly, we have found that the reduplication seen in Capgras syndrome can even involve the patient's own self" (p. 277). Capgras delusion involving one's own self has long been described in the literature.

Rather than get even more pedantic and mention the few mistranslations into French and German, some typos, and two or three errors in the reference list, I will return to the question of *just how vague* Ramachandran's answers to the seven big questions of the uniqueness of the human species are. The problem with the *tabula Rama* is not that one or more legs are rotten, but that collectively they can only guarantee stability as long as they are placed on an anthropomorphic terrain. Species have evolved to survive in all manner of barren and inhospitable environments and those that did survive have all reached a degree of specialisation that makes them unique in some way or another. Take *bonellia viridis*, a greenish marine worm, which prefers to live on relatively shallow, coastal sea floors. The sausage-shaped female, about 15 cm long, has a thin feeding proboscis of between 1 and 2 m length which she lets gently float in the water. This tusk produces a substance, bonellin, that is highly toxic to other small animals (which are paralysed and eaten up), but lures the genderless larvae of *bonellia* to approach. On contact with the tusk, the larvae turn into males, which remain tiny, are swallowed, and spend the rest of their life in the female's genital tract. Those larvae, however, that happen to land on the sea floor develop into females. The ratio of females to males in this worm population is thus elegantly regulated: In places with a high density of females, the chance of making contact with a tusk (and consequently of turning into a male) is high and, vice versa, if there are few tusks, more females result because most larvae will make contact with the sea floor. I am not saying that human males should envy *bonellia* for being guaranteed an almost entirely sexual life in a secure place within our partner, but we should admire the uniqueness of this species' mechanism for controlling its gender distribution (Berec, Schembri, & Boukal, 2005). If one day human civilisation is erased by self-inflicted disaster, it will not be some primate relatives that survive as Ramachandran assumes. Marine worms, bacteria, or insects will probably be much better off.

But I agree with Ramachandran when he dismisses either/or dichotomies and asks: "Why can't we be a branch of the animal kingdom and a wholly unique and gloriously novel phenomenon in the universe?" (p. 4). Hence, we should probably ask: Why can't Ramachandran's book be one of many

books on the uniqueness of human nature and at the same time a novel (even if largely recycled) and entertaining contribution to the literature on cognitive neuroscience? I think I will recommend this book to any of my friends who do not shun pop (neuro)science in principle. Although the *Tell-Tale Brain* does contain a lot of pop on the surface, the overall content is very much Popper, who once clearly stated that "bold ideas, unjustified anticipations and speculative thought are our only means for interpreting nature" (Popper, 1959/1980, p. 280).

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